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Memorandum

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Date: *July 6, 2007*

Subject: *Technical Memorandum - Lessons Learned*
Installation of Six Groundwater Extraction and Injection Wells for Pre-Remediation Activities
Remediation of Volatile Organic Compounds
Former C-6 Facility, Los Angeles, California

Camp Dresser & McKee Inc. (CDM) has prepared this Technical Memorandum (TM) to summarize the Lessons Learnt during the drilling and installing of groundwater extraction and injection wells (herein referred to as the groundwater drilling program) in October and November 2006 at the Former C-6 Facility (site).

1.0 Objectives

The objectives of the Lessons Learnt process are to:

- Identify which project practices are beneficial, as well as which project practices that need improvements; and
- Gather input from the project team to improve the overall planning, execution and management process for future groundwater drilling programs.

2.0 Background

The scope of work included the drilling, continuous sampling, installation, and development of six groundwater wells using the sonic drilling method. Two wells were completed in the B-Sand to depths of about 90 feet below ground surface (bgs) and four wells in the C Sand to

depths of about 125 feet bgs. To minimize the potential for cross contamination during installation of the C-Sand wells, a conductor casing was required to seal off the B-Sand from the C-Sand. In addition to well construction, the scope of work also included the collection of soil and groundwater samples for laboratory treatability testing. The work was performed on two improved properties (Former Bldgs 1/36 and 2) redeveloped from the former C-6 Facility. Both properties are occupied by large warehouses with one in operation and the other undergoing owner-improvements.

3.0 Key Team Members

- Consultant: CDM
- Environmental Contractor: AVOCET Environmental, Inc.
- Drilling Contractor: Cascade
- BRC Oversight Consultant: Haley & Aldrich, Inc.

4.0 Document Organization

Input from the ground drilling program team members were classified into Plus Items (beneficial practices) and Delta Items (practices that need improvements). The findings for these items are discussed below:

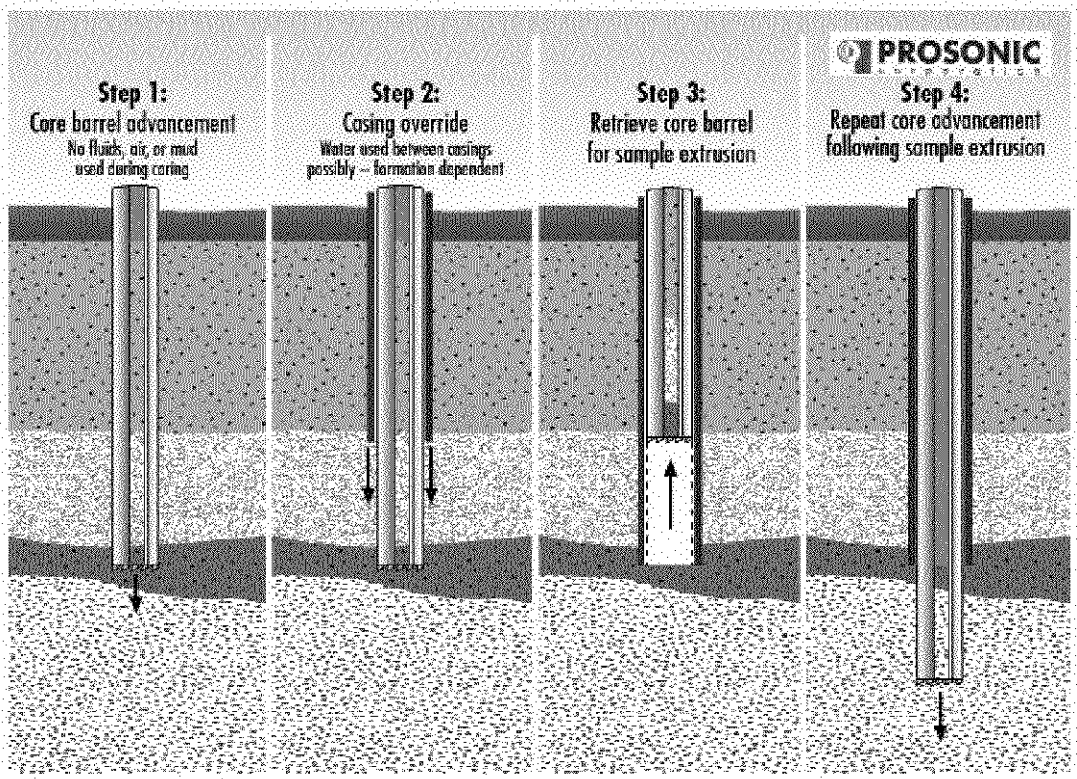
4.1 Plus Items

- Prior to drilling, pavement cut-out and hand augering to a depth of 10 feet below ground surface (ft bgs) was completed at three locations (triangular) around each well. This practice avoided damaging underground remediation and other Site utilities
- Good owner/tenant relations and advance pre-fieldwork notices combined with frequent professional updates during the well installation program resulted in no owner/tenant complaints even though the field work extended beyond the initial duration estimate.
- Weekly team teleconferences, initiated by BRC Oversight Consultant and which included the Drilling Contractor, helped everyone stay informed and provided a good forum for real-time issue resolution and process improvement.
- Quick turnaround regarding well design details was provided by the Consultant to Environmental Contractor following receipt of field boring logs ensuring no delays.

4.2 Delta Items

4.2.1 Drilling

To drill a borehole using the sonic drilling method, the core barrel is advanced, generally in increments of 5 to 10 feet, into the formation using resonant energy. The core barrel is then overridden by the conductor casing to prevent the borehole from collapsing when the core barrel is removed to extrude the core. Then the process is repeated as shown in the drawing below:



Step 3 of the preceding drawing, however, is somewhat simplified in that it presumes that the core barrel fits tightly within the conductor casing and that upon removal of the core barrel all soil is removed from the interior of the conductor. More commonly, however, the core barrel is somewhat (two to several inches) smaller in diameter than the conductor casing. The greater the differences in diameters, the greater the amount of cutting required of the conductor casing and greater the amount of soil filling the conductor casing as it is advanced.

At the Site, drilling was initiated with a 6-inch diameter core barrel and 10-inch diameter conductor casing. The plan was to advance the 10-inch diameter conductor to a depth of between 80 and 85 feet, seal the bottom of the conductor casing with coated bentonite pellets

to isolate the B-Sand from the C-Sand, and continue drilling with an 8-inch diameter conductor casing to total depth (TD). A few issues quickly became evident: 1) the drill rig/individual driller seldom, if ever, had used 10-inch diameter conductor casing, which is very heavy and awkward to handle; and 2) the 6-inch core barrel was not creating a large enough hole to advance 10-inch diameter casing. Installing 10-inch casing into a 6-inch hole required a lot of effort and resulted in slow progress. Moreover, since the casing was being relied upon to perform much of the cutting, it frequently became plugged with cuttings, requiring it to be removed from the ground and manually cleared, resulting in significant down time.

The problem was acknowledged by the individual driller, who immediately began working with his management to obtain a core barrel of larger diameter (8 inches). Unfortunately, a larger core barrel was not immediately available and had to be fabricated, resulting in further delays. Drilling progress (i.e., production) using a 8-inch diameter core barrel and 10-inch diameter conductor casing or 6-inch diameter core barrel and 8-inch conductor casing was satisfactory.

Once the driller reached the target conductor casing depth of 85 feet, the bentonite seal was installed, allowed to hydrate, and drilling resumed with the 6-inch core barrel and 8-inch diameter casing. However, the sonic energy of drilling caused the silt supporting the 10-inch diameter casing to lose its cohesion (i.e., liquefy), thereby causing the conductor to settle deeper into the boring. Drilling could not proceed until a tool was delivered to the site to secure the outer casing.

Lessons Learned:

- The appropriate procedures utilized by the drilling company and the size of the core barrel should be discussed during the proposal stage to ensure adequate production rates.
- Only Drilling Contractors experienced in specified drilling techniques should be used on the job site. Consider establishing minimum experience requirements for drilling companies doing sonic drilling and have a procedure to verify the particular driller's experience.
- The difference in diameter between the core barrel and conductor casing should be 2 inches or less. If the project requires casing larger than 8 inches in diameter, make certain that the driller has experience working with large casing.

- If the project requires the use of two conductor casings to seal off an upper contaminated saturated zone, be certain that the Drilling Contractor is equipped to secure the outer casing at the ground surface.

- Although this project was scheduled weeks in advance, it appears that little thought was given to the details by the drilling contractor. This was evident by the preceding examples as well as by the delivery of incorrect or insufficient materials to the Site, which collectively resulted in substantial delays. Some of these included: no extensions to allow hand augering to 10 feet, socks around drains for containment of any fluids spills during drilling, and no 5-foot screen sections to allow flexibility in well design (additional screen had to be brought to the Site). The lessons learned therefore include:

  - Drilling Contractor's bid response should include attending a pre-construction meeting to discuss the details of the drilling program;

  - Key field drilling equipment (hand augers, containment equipments) should be present on the support truck, prior to arrival at the job site; and

  - Any permit requirements (hot wire permits), should be well established and obtained during the pre-field activities.

- Part of the responsibility for ensuring that the details have been considered by the Drilling Contractor rests with the Environmental Contractor. For non-conventional drilling, basically any non-routine drilling project, the Environmental Contractor should talk through every detail of the drilling method, inquire as to possible problems that have been encountered at other projects in similar settings that used similar methods, and inquire as to the drill crew's experience in the site area. Prior to mobilizing equipment to the site, the Environmental Contractor must be satisfied that the Drilling Contractor understands the site conditions and project requirements.

- Ensure that the Drilling Contractor provides a "realistic schedule". The initial schedule, as provided by the Drilling Contractor, called for drilling and installation of the B-Sand wells in one day and the C-Sand wells in two days – for a total of 11 days. The Drilling Contractor later acknowledged that this was probably unrealistic. The drilling and installation actually required 16 days (October 18 to November 8). Probably a more realistic, yet still aggressive, schedule would have been 2 days for each of the B-Sand wells and 2.5 days for the C-Sand wells – for a total of 14 days.

4.2.2 Treatability Sample Collection and Shipping

The scope of work required the collection of 10 liters of groundwater and 5 kilograms of soil samples from each of the B- and C-Sands. The groundwater samples were to be collected from a C-Sand monitoring well using low-flow purge and sample methods. The soil samples were to be collected with minimal potential for atmospheric contact. The samples had to be received by CDM's Environmental Treatability Laboratory in Bellevue, Washington no later than October 25, 2006. The groundwater samples were collected using standard procedures, without incident, and shipped overnight to Bellevue, Washington on October 23, 2006. Two extra liters of groundwater were collected and stored on ice for use in packaging the soil samples.

The B-Sand treatability samples were collected on Tuesday, October 24, 2006 using 4-inch diameter by 30-inch long steel Shelby tubes. The samples were collected by attaching a Shelby tube to the end of the drill rod using a special adapter, lowering the sampler through the water column to the soil interface and driving the sampler into the native formation. Since the sample was collected through standing water, which would displace atmospheric air from the sampler, pre-purging of the tube with argon was not performed. Upon removal from the borehole, the tube was immediately sealed with Teflon paper and plastic caps wrapped with Parafilm. As requested by the laboratory, the 30-inch Shelby tube was then cut into 12-inch long sections and about an inch of soil was removed from each end and replaced with groundwater. The ends of the tube were re-sealed, packed into coolers with ice and shipped via overnight delivery to CDM's laboratory in Washington.

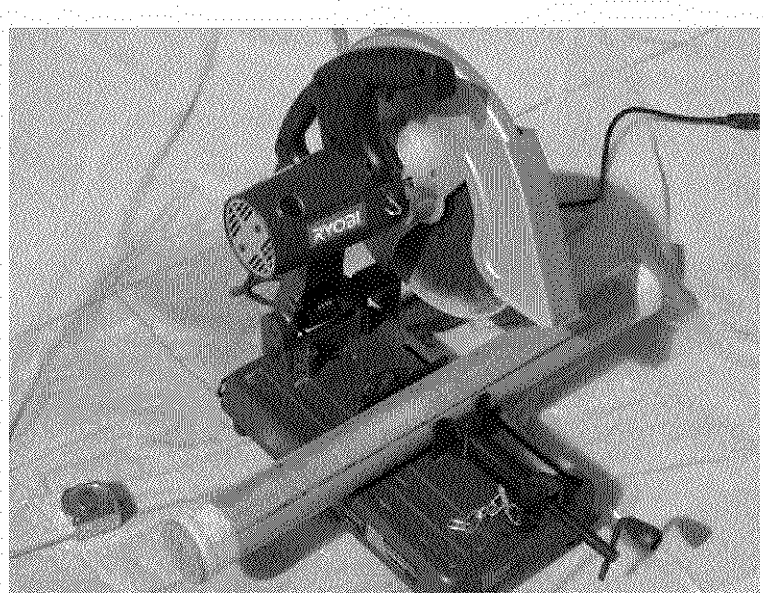


Photo showing a 30-inch Shelby tube on the chop saw to be cut into 12-inch lengths.

Due to drilling problems, the C-Sand treatability samples could not be collected until the morning of October 25, 2006. As previously noted, the laboratory schedule required that these samples were received by the laboratory no later than October 25, 2006. Therefore, these samples had to be shipped "same day" to Bellevue, Washington.

Lessons Learned:

- Due to air cargo restrictions imposed after 9/11, same day shipping is more complicated than it used to be. All "same-day" shipments - even those by FedEx and similar cargo carriers - are placed on commercial airlines (i.e., Alaska Airlines, United, etc.). The Transportation Security Administration (TSA) imposed restrictions in the wake of 9/11 that require senders of shipments of 16 ounces or more to be "Known Shippers". This requires either: 1) completion of an airline-specific application, which would probably take weeks to process, or 2) that your company had a FedEx account prior to 2001 if using FedEx.

- During such future programs, more flexibility needs to be allowed for sample receiving dates to account for delays in field activities.

- Treatability sample collection procedures should have been prepared and provided to the Contractor during the RFP process and no later than the Kick off meeting. Instead they were provided one day prior to beginning of field activities, providing not enough time for the Contractor to coordinate and gather supplies for this specialized sample collection.

4.2.3 Project Coordination/Management

Since the project did not progress according to schedule and because there were numerous interested parties, many questions arose early in the project regarding the nature of the delays. To ensure that all parties were fully informed, daily project status reports were sent out via electronic mail and weekly conference calls were held to discuss project status, ask questions, and solicit advice.

Lessons Learned:

- For projects with a great number of interested parties and/or projects that do not proceed according to schedule, the Consultant shall consider initiating weekly conference calls and sending out daily project status reports and to keep interested parties involved and informed.

4.2.4 Well Surveying

Due to cost considerations, Avocet did not utilize the incumbent land surveyor to determine the locations and elevations of the newly installed monitoring wells. The new surveyor was

provided a copy of Boeing's survey specifications (Haley & Aldrich, November 20, 2005) as well as the coordinates/elevations of several existing monitoring wells to ensure consistency with the previous coordinate system. In surveying the existing points, the new surveyor was unable to duplicate the incumbent surveyor's work. Subsequent efforts revealed that the incumbent surveyor's work was off by -7.02N and 3.75E. This inaccuracy was communicated to Haley & Aldrich who is working with the surveyor to determine the extent of the problem.

Lessons Learned:

- A fresh set of eyes may shed a fresh perspective on an otherwise routine task.

4.2.5 Health and Safety Incident

While moving the drill rig tender truck forward, the second hand for the drilling subcontractor scraped the wrought iron landing for the mechanical gate at the Site (Former Bldg. 1/36). Nobody was hurt and nothing was spilled, but property damage did result. The incident occurred because the second hand, although appropriately trained and authorized to operate the truck, did not remove the bag bracket, which protrudes from the side of the truck. It was the bracket, not the truck itself that contacted the gate landing.

Lessons Learned:

- No vehicle should be moved, in either forward or reverse, on a job site prior to the operator: (1) walking around the vehicle to check for obstructions not visible from the cab and/or protrusions from the truck body presenting a possible hazard; and (2) recruiting a spotter to direct the move and provide warnings of potential hazards (not only on the road, but also overhead).

4.2.6 Waste Profiling

Investigation-derived waste (IDW) generated during well installation activities (soil cuttings, equipment decontamination rinsate, and purge/development water) was expected to be non-hazardous. However, the waste profiling analytical data resulted the liquid IDW to be classified as hazardous waste due to elevated concentrations of trichloroethylene and 1,1-dichloroethylene. Since there was no EPA ID Number available for the facility (required for hazardous waste disposal), BRC had to get one established at the last minute. In addition, not enough lead time was given to BRC for signing the manifests, considering that it was around the Thanksgiving holidays.

Lessons Learned:

- Plan for both hazardous and non-hazardous wastes to be generated during any such drilling program. This planning should involve contacting Boeing Waste Specialist well in advance to make sure that the proper ID numbers and other information are available and provided to the appropriate subcontractors PRIOR to beginning the project.

- Communicate with BRC regarding the schedule for manifest review and signing WELL IN ADVANCE of generating the manifests.

- Provide at least 3 business days lead time for BRC to review and sign manifests before the waste pickup is scheduled to occur. More lead time should be providing during times of vacations and holidays.

5.0 Conclusions

The Lessons Learned process is an important part of the Boeing remediation program and benefits the overall environmental program through continuous process improvement and ultimately better results at a lower cost. In the spirit of continuous process improvement, any additional feedback regarding implementation of these Lessons Learned or ideas on improving the listed Delta items would be appreciated and encouraged.

Should you have any questions concerning the contents of this memorandum or require additional information, please contact CDM.